

Supplementary Figures and Tables

Supplementary Material to: Artificial oyster reefs can facilitate the recovery of lost ecosystem function in fragmented seagrass habitat

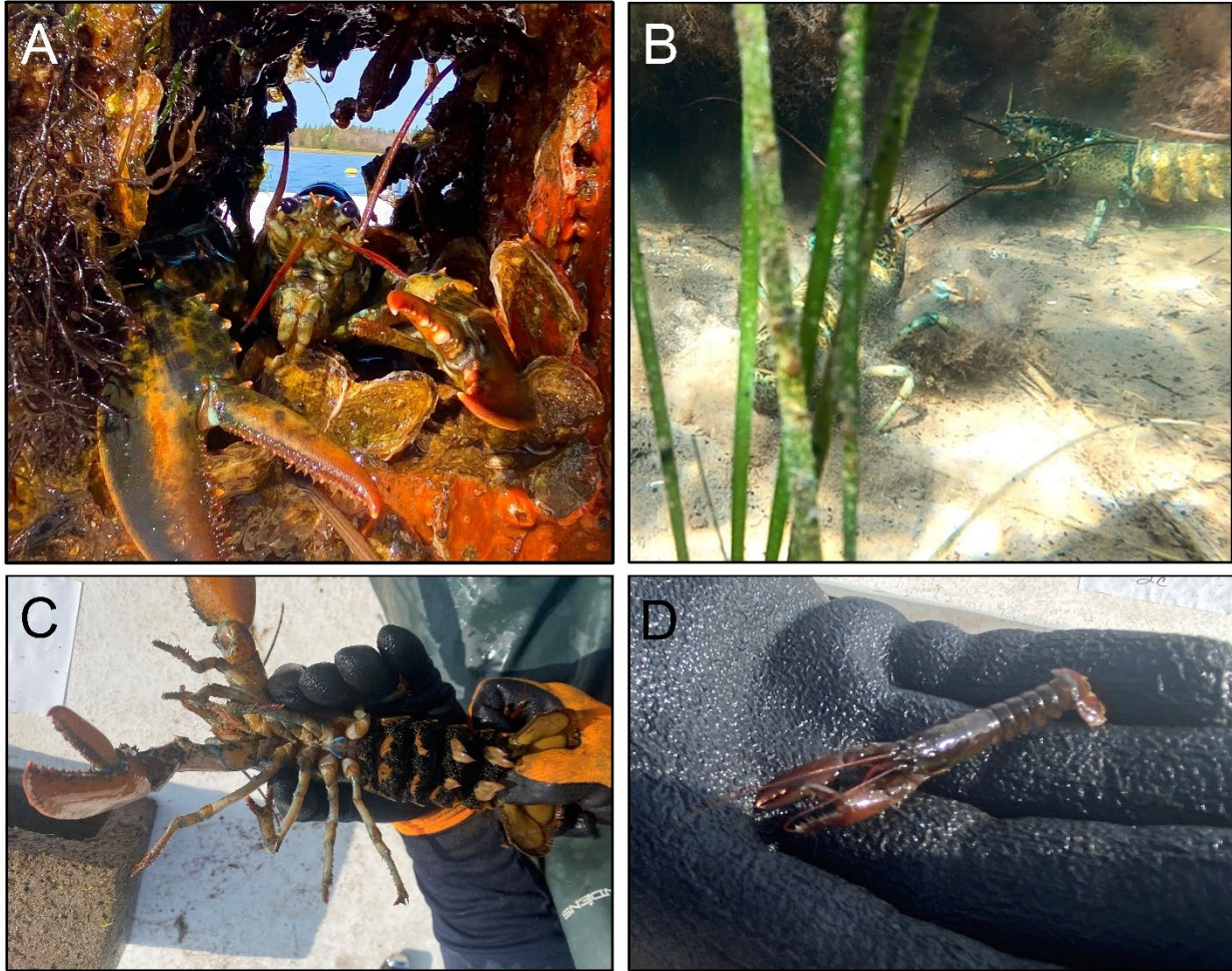


Figure S1. Notable observations of American lobsters (*Homarus americanus*) engaging with the artificial reefs, including (A) a sheltering lobster amongst some juvenile oysters and other organisms after bringing a concrete block onto the boat, (B) two lobsters fighting over access to a reef, (C) a berried female from one of the reefs, and (D) a juvenile recruit from one of the reefs.

Table S1. Model information for data loggers used to monitor abiotic parameters.

Parameter	Logger model	Link
Dissolved oxygen	Onset HOBO U26-001 dissolved oxygen logger	https://www.onsetcomp.com/products/data-loggers/u26-001?srsltid=AfmBOop_OLGXQ0DliByQCPk7jHXzF-g6xCtvFpKXLYVDPydL6BX14Ogw
pH	Onset HOBO MX2501 pH and temperature logger	https://www.onsetcomp.com/products/data-loggers/mx2501?srsltid=AfmBOorCBO1OxM2rDKGJZKXs40iV198FoWYw3p6vUACcwyRk5MrStVbr
Temperature	Onset HOBO MX2501 pH and temperature logger	https://www.onsetcomp.com/products/data-loggers/mx2501?srsltid=AfmBOorCBO1OxM2rDKGJZKXs40iV198FoWYw3p6vUACcwyRk5MrStVbr
Turbidity	Observer Analite NEP-595 turbidity logger	https://observer.com/products/nep-595-turbidity-logging-probe/

Table S2. Results of pairwise comparisons between individual reef year classes for taxonomic richness and whole-community biomass. Estimate = model-predicted difference (direction and magnitude) of the first factor level in the contrast relative to the second level in the contrast, reported on the log-scale; SE = standard error; df = degrees of freedom.

Richness

Contrast	Estimate	SE	df	z-ratio	p-value
0 year - 1 year	-0.95	0.15	Inf	-6.57	<0.0001
0 year - 2 year	-0.93	0.15	Inf	-6.39	<0.0001
1 year - 2 year	0.02	0.11	Inf	0.22	0.9742

Biomass

Contrast	Estimate	SE	df	z-ratio	p-value
0 year - 1 year	0.02	0.00	24	6.65	<0.0001
0 year - 2 year	0.03	0.00	24	7.49	<0.0001
1 year - 2 year	0.00	0.00	24	6.05	<0.0001

Table S3. Results of redundancy analysis RDA models for differences in abundance and biomass of whole communities, and sessile benthic animals only, across year classes.

Whole-community biomass

Source of variation	df	Variance	F-value	p-value	Adjusted R ²
Model	2	0.43	42.16	<0.0001	0.76
Residuals	24	0.12	-	-	-

Sessile biomass

Source of variation	df	Variance	F-value	p-value	Adjusted R ²
Model	2	0.46	66.77	<0.0001	0.83
Residuals	24	0.08	-	-	-

Whole-community abundance

Source of variation	df	Variance	F-value	p-value	Adjusted R ²
Model	2	0.07	10.81	<0.0001	0.43
Residuals	24	0.08	-	-	-

Sessile abundance

Source of variation	df	Variance	F-value	p-value	Adjusted R ²
Model	2	0.17	13.14	<0.0001	0.48
Residuals	24	0.16	-	-	-

Table S4. Results of RDA pairwise comparisons between individual reef year classes for abundance and biomass of whole communities, and sessile benthic animals only, across year classes. df = degrees of freedom, SS = sum of squares.

Whole-community biomass

Contrast	df	SS	z-ratio	p-value
0 year - 1 year	1	0.31	37.30	<0.0001
0 year - 2 year	1	0.41	51.98	<0.0001
1 year - 2 year	1	0.25	36.72	<0.0001

Sessile biomass

Contrast	df	SS	z-ratio	p-value
0 year - 1 year	1	0.39	64.40	<0.0001
0 year - 2 year	1	0.45	94.08	<0.0001
1 year - 2 year	1	0.22	43.43	<0.0001

Whole-community abundance

Contrast	df	SS	z-ratio	p-value
0 year - 1 year	1	0.06	18.13	<0.0001
0 year - 2 year	1	0.06	10.32	<0.0001
1 year - 2 year	1	0.04	6.77	<0.0001

Sessile abundance

Contrast	df	SS	z-ratio	p-value
0 year - 1 year	1	0.17	16.65	<0.0001
0 year - 2 year	1	0.17	23.13	<0.0001
1 year - 2 year	1	0.05	4.22	<0.0001

Table S5. Results of generalized linear models for the effect of reef year class on the abundance and biomass of oyster spat and adults. LR χ^2 = likelihood-ratio chi square test statistic; df = degrees of freedom.

Abundance

Life stage	Source of variation	LR χ^2	df	p-value
Spat	Year class	27.8	2	<0.0001
Adult	Year class	331.2	2	<0.0001

Biomass

Life stage	Source of variation	LR χ^2	df	p-value
Spat	Year class	28.3	2	<0.0001
Adult	Year class	5261.7	2	<0.0001

Table S6. Results of pairwise comparisons between individual reef year classes for abundance and biomass of oyster spat and adults. Estimate = model-predicted difference (direction and magnitude) of the first factor level in the contrast relative to the second level in the contrast, reported on the log-scale; SE = standard error; df = degrees of freedom.

Abundance

Life stage	Contrast	Estimate	SE	df	z-ratio	p-value
Spat	0 year - 1 year	1.89	0.34	24	5.51	<0.0001
Spat	0 year - 2 year	0.87	0.34	24	2.54	0.0459
Spat	1 year - 2 year	-1.02	0.34	24	-2.97	0.0175
Adults	0 year - 1 year	-4.63	0.29	24	-16.14	<0.0001
Adults	0 year - 2 year	-7.26	0.29	24	-25.32	<0.0001
Adults	1 year - 2 year	-2.63	0.29	24	-9.18	<0.0001

Biomass

Life stage	Contrast	Estimate	SE	df	z-ratio	p-value
Spat	0 year - 1 year	1.35	0.28	24	4.81	0.0002
Spat	0 year - 2 year	1.12	0.28	24	3.99	0.0015
Spat	1 year - 2 year	-0.23	0.28	24	-0.82	0.6937
Adults	0 year - 1 year	-4.19	0.24	24	-17.38	<0.0001
Adults	0 year - 2 year	-9.17	0.24	24	-38.06	<0.0001
Adults	1 year - 2 year	-4.98	0.24	24	-20.68	<0.0001

Table S7. Results of linear models testing for effects of stand, time of day, and Julian date (covariate) on dissolved oxygen, pH, and temperature. df = degrees of freedom, SS = sum of squares, MS = mean squares.

Dissolved oxygen

Source of error	df	SS	MS	F-value	p-value
Stand	1	58.86	58.86	33.60	<0.0001
Time of day	1	26.53	26.53	15.14	<0.0001
Julian date	29	351.49	12.12	6.92	<0.0001
Stand × Time of day	1	47.93	47.93	27.36	<0.0001
Stand × Julian date	29	50.08	1.73	0.99	0.4873
Residuals	1358	2378.68	1.75	-	-

pH

Source of error	df	SS	MS	F-value	p-value
Stand	2	2.80	1.40	123.58	<0.0001
Time of day	1	0.40	0.40	34.99	<0.0001
Julian date	29	9.40	0.32	28.62	<0.0001
Stand × Time of day	2	0.49	0.25	21.84	<0.0001
Stand × Julian date	58	0.47	0.01	0.71	0.9521
Residuals	2037	23.07	0.01	-	-

Temperature

Source of error	df	SS	MS	F-value	p-value
Stand	2	12.80	6.40	10.58	<0.0001
Time of day	1	6.50	6.54	10.80	<0.0001
Julian date	29	5269.30	181.70	300.34	<0.0001
Stand × Time of day	2	6.50	3.24	5.36	0.0048
Stand × Julian date	58	31.40	0.54	0.89	0.6985
Residuals	2037	1232.30	0.61	-	-

Table S8. Results of the generalized linear mixed model (Gamma distribution) for effects of stand, time of day, and Julian date (covariate) on turbidity. . LR χ^2 = likelihood-ratio chi square test statistic, df = degrees of freedom.

Source of error	LR X^2	df	p-value
Stand	863.18	2	<0.0001
Time of day	13.82	1	0.0002
Julian date	466.17	17	<0.0001
Stand \times Time of day	29.07	2	<0.0001
Stand \times Julian date	191.14	34	<0.0001

Table S9. Results of pairwise comparisons between the three stands for each of the four abiotic parameters monitored. Estimate = model-predicted difference (direction and magnitude) of the first factor level in the contrast relative to the second level in the contrast, reported on the log-scale; SE = standard error; df = degrees of freedom. For “z-ratio/t-ratio” column, z-ratios apply to dissolved oxygen, pH, and temperature (linear models), while t-ratios apply to turbidity (generalized linear mixed model with Gamma distribution).

Dissolved oxygen

Contrast	Estimate	SE	df	z-ratio/t-ratio	p-value
Reef - Inside	-	-	-	-	-
Reef - Outside	-	-	-	-	-
Inside - Outside	0.31	0.07	1358	4.20	<0.0001

pH

Contrast	Estimate	SE	df	z-ratio/t-ratio	p-value
Reef - Inside	-0.05	0.01	2037	-8.95	<0.0001
Reef - Outside	-0.10	0.01	2037	-16.76	<0.0001
Inside - Outside	-0.05	0.01	2037	-7.81	<0.0001

Temperature

Contrast	Estimate	SE	df	z-ratio/t-ratio	p-value
Reef - Inside	-0.05	0.04	2037	-1.16	0.4749
Reef - Outside	-0.22	0.04	2037	-5.02	<0.0001
Inside - Outside	-0.17	0.04	2037	-3.86	<0.0001

Turbidity

Contrast	Estimate	SE	df	z-ratio/t-ratio	p-value
Reef - Inside	-1.92	0.11	1239	-17.87	<0.0001
Reef - Outside	-1.85	0.11	1239	-17.16	<0.0001
Inside - Outside	0.08	0.06	Inf	1.29	0.0093

Table S10. Results of pairwise comparisons between day and night at each of the three stands for each of the four abiotic parameters monitored. Estimate = model-predicted difference (direction and magnitude) of the first factor level in the contrast relative to the second level in the contrast, reported on the log-scale; SE = standard error; df = degrees of freedom. For “z-ratio/t-ratio “ column, z-ratios apply to dissolved oxygen, pH, and temperature (linear models), while t-ratios apply to turbidity (generalized linear mixed model with Gamma distribution).

Dissolved oxygen

Stand	Contrast	Estimate	SE	df	z-ratio/t-ratio	p-value
Outside	Day - Night	-0.09	0.10	1358	-0.92	<0.0001
Inside	Day - Night	0.66	0.10	1358	6.47	<0.0001
Reef	Day - Night	-	-	-	-	-

pH

Stand	Contrast	Estimate	SE	df	z-ratio/t-ratio	p-value
Outside	Day - Night	-0.02	0.01	2037	-1.82	0.0692
Inside	Day - Night	0.04	0.01	2037	5.10	<0.0001
Reef	Day - Night	0.06	0.01	2037	7.10	<0.0001

Temperature

Stand	Contrast	Estimate	SE	df	z-ratio/t-ratio	p-value
Outside	Day - Night	-0.04	0.06	2037	-0.67	0.5006
Inside	Day - Night	0.22	0.06	2037	3.57	0.0004
Reef	Day - Night	0.18	0.06	2037	3.03	0.0025

Turbidity

Stand	Contrast	Estimate	SE	df	z-ratio/t-ratio	p-value
Outside	Day - Night	-0.12	0.02	1239	-4.99	0.0001
Inside	Day - Night	0.03	0.02	1239	1.71	0.0883
Reef	Day - Night	0.09	0.12	1239	0.75	0.4537